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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/709,355	04/29/2004	Saad Ahmed Sirohey	144482	3354

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EXAMINER	
MACKOWEY, ANTHONY M	

ART UNIT	PAPER NUMBER
2624	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/709,355	SIROHEY ET AL.	
	Examiner	Art Unit	
	Anthony Mackowey	2624	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 February 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-7 and 9-19* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7 and 9-19* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 May 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on December 3, 2007 has been entered.

Response to Arguments

Applicant's arguments filed December 3, 2007 have been fully considered but they are not persuasive.

Applicant submits the combination of Li and Lindeberg fails to disclose or suggest "isolating a selected region of interest from the multi-dimensional dataset...generating a plurality of differential operators <u>for the selected region of interest, separate from the multi-dimensional dataset, using a discrete approximation of an analytic function</u>." As addressed in the Final Office Action mailed October 2, 2007 (pages 2 and 3), Li teaches the lung regions are first segmented from the original images (Fig. 2; col. 12, lines 13-29) and then the three enhancement filters are applied to the segmented lung regions (Fig. 2; col. 12, lines 30-34) While the explicitly recited "region of interest" of Li (col. 12, line 36) corresponds identifying candidate nodules and does not meet the limitations recited in the claims, the segmentation of the lung region and subsequent filtering meet the requirements of the region of interest recited in claim 1 (and similarly in claims

15, 16, 17, 18 and 19). Therefore, the segmentation of the lung regions taught by Li may be reasonably construed as isolating a selected region of interest, separate from the multi-dimensional dataset, as recited in the claims.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-7, 11, 12 and 14-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 6,937,776 to Li et al. (hereafter referred to as "Li") in view of "Discrete Derivative Approximations with Scale-Space Properties: A Basis for Low-Level Feature Extraction" by Lindeberg.

Regarding claim 1, Li discloses a method for processing of a multi-dimensional dataset corresponding to an imaging volume (col. 4, lines 59-67), the method comprising:

accessing the multi-dimensional dataset (col. 19, lines 29-40);

isolating a selected region of interest from the multidimensional dataset, said selected region of interest comprising a subset of the imaging volume (col. 12, lines 12-34);

generating a plurality of differential operators for selected region of interest, separate from the multi-dimensional dataset, using an approximation of an analytic function (col. 7, line 11 – col. 10, line 37; col. 12, lines 30-67, Li teaches generating the second order derivatives of

the images and approximations to the second order derivatives and constructing a Hessian matrix); and

forming a plurality of geometric responses based on a plurality of differential operators resultant from said generating (col. 6, line 10 – col. 7, line 32; col. 12, lines 30-67, Li teaches geometric filters based on the second order derivatives.).

Li discloses generating a plurality of differential operators for the multi-dimensional dataset using an approximation of an analytic function (col. 10, line 6-37) but does not explicitly disclose using a discrete approximation of an analytic function. However, Lindeberg clearly teaches using the discrete approximations of an analytic function (discrete derivative approximations) to determine the second order derivatives for use in a feature detector (Abstract; page 19, Section 6.1.3, second paragraph; page 16, Figure 3).

The teachings of Li and Lindeberg are combinable because they are both concerned with using filters derived from second order derivatives for feature extraction. It would have been obvious to one of ordinary skill in the art that the method taught by Li could be modified so the generating of a plurality of differential operators for the multi-dimensional dataset uses a discrete approximation of an analytic function as taught by Lindeberg because the discrete approximations can be computed directly from smoothed image values at different scales without the need for repeating the smoothing operation, thus reducing the computation requirements making it more efficient (Lindeberg, page 2, lines 32-41 (last full paragraph); page 12, section 4.1).

Regarding claim 2, Lindeberg further discloses scale-space processing the multi-dimensional dataset with multi-resolution sampling (page 25, section 7.1).

Regarding claim 3, Li further discloses iterating said generating and forming over several scales to determine said plurality of responses for each scale; and determining said plurality of geometric responses based on said iterating (Fig. 11; col. 11, lines 29-60).

Regarding claim 4, Li further discloses filtering the multi-dimensional dataset with a smoothing kernel based on an analytic function; said smoothing kernel generating a filtered multi-dimensional dataset (Fig. 11, S3; col. 10, line 46 – col. 11, line 60).

Regarding claim 5, Li further discloses said analytic function is a Gaussian (Fig. 11, S3; col. 10, line 46 – col. 11, line 60).

Regarding claim 6, Li further discloses said plurality of differential operators correspond to an n-th derivative of said analytic function, where n is greater than or equal to one (col. 7, line 11 – col. 11, line 60, Li teaches second derivatives.)

Regarding claim 7, the combination of Li and Lindeberg further discloses identifying a plurality of discrete derivative approximations that when convolved with said analytic function, approximates an analytical derivative of said analytic function. Lindeberg teaches identifying a plurality discrete approximations and Li teaches identifying approximations that when convolved

with said analytic function, approximate an analytic derivative of said analytic function (see arguments and citations presented above for claim 1 and additionally Li, col. 10, line 38 - col. 11, line 7).

Li and Lindeberg are silent with regard to optimizing said discrete derivative approximations in a least squares sense to reduce an error between said plurality of discrete derivative approximations and said analytical derivative of said analytic function. The Examiner takes Official Notice that optimization in a least squares sense if well known in the art and it would have been obvious to one of ordinary skill in the art to optimize the discrete derivative approximations in a least squares sense to reduce an error between the discrete derivative approximations and the analytical derivative of the analytic function because optimization using least squares techniques is exceedingly well known for quantifying and reducing differences (error) between two functions.

Regarding claim 11, Lindeberg further discloses generating a downsampled multidimensional dataset based on said multi-resolution sampling (page 25, Section 7.1).

Regarding claim 12, Li further discloses isolating a selected region of interest from at least one of said multi-dimensional dataset and said downsampled multi-dimensional dataset, said selected region of interest comprising a subset of the imaging volume (col. 12, lines 12-55, Examiner notes the use of alternative language. Li teaches isolating a selected region of interest from the multi-dimensional dataset.).

Regarding claim 14, neither Li nor Lindeberg explicitly disclose said processing of a multi-dimensional dataset is executed in less than one minute, however one of ordinary skill in the art at the time the invention was made would have found it obvious that the processing taught by the combination of Li and Lindeberg, as presented above in the rejection of claim 1, is capable of being performed in less than one minute. If the presently claimed processing method is capable of being performed in less than one minute, because the combination of Li and Lindeberg disclose the same steps, then the processing method taught by the combination of Li and Lindeberg would also be performed in less than one minute when performed by an equivalent processing apparatus/computer.

Regarding claim 15, Li discloses a method for processing of a multi-dimensional dataset corresponding to an imaging volume (col. 4, lines 59-67).

Li does not disclose processing the multidimensional dataset with multi-resolution sampling to establish a downsampled multidimensional dataset, however Lindeberg discloses multi-resolution sampling to establish a downsampled multidimensional dataset (page 25, section 7.1). One of ordinary skill in the art at the time the invention was made would have been motivated to modify the method taught by Li to include multiresolution sampling to establish a downsampled multidimensional dataset as taught by Lindeberg in order to improve computational efficiency (Lindeberg, page 25, section 7.1, first paragraph).

Li further discloses identifying a region of interest from the multi-dimensional dataset; said region of interest comprising a subset of the imaging volume (col. 12, lines 12-34).

In view of the modification to the method of Li to include sampling the multi-resolution sampling as taught by Lindeberg is would have further been obvious to one of ordinary skill in the art to process said downsampled multidimensional dataset based on said region of interest and establishing a multi-dimensional datasubset in view of Li's teaching of establishing a datasubset based on a region of interest (col. 12, lines 12-34).

Li further discloses filtering the a multi-dimensional datasubset, separate from the multi-dimensional dataset, with a smoothing kernel based on an analytic function; said smoothing kernel generating a filtered multi-dimensional datasubset (Fig. 11, S3; col. 10, line 46 – col. 11, line 60).

Li also discloses generating a plurality of differential operators for the multi-dimensional datasubset using an approximation of an analytic function (col. 10, line 6-37) but does not explicitly disclose using a discrete approximation of an analytic function. However, Lindeberg clearly teaches using the discrete approximations of an analytic function (discrete derivative approximations) to determine the second order derivatives for use in a feature detector (Abstract; page 19, Section 6.1.3, second paragraph; page 16, Figure 3). It would have been obvious to one of ordinary skill in the art that the method taught by Li could be modified so the generating of a plurality of differential operators for the multi-dimensional dataset uses a discrete approximation of an analytic function as taught by Lindeberg because the discrete approximations can be computed directly from smoothed image values at different scales without the need for repeating the smoothing operation, thus reducing the computation requirements making it more efficient (Lindeberg, page 2, lines 32-41 (last full paragraph); page 12, section 4.1).

Li further discloses forming a plurality of geometric responses based on a plurality of differential operators resultant from said generating (col. 6, line 10 – col. 7, line 32).

Regarding claim 16, Li discloses a method for processing of a multi-dimensional dataset (col. 4, lines 59-67). Li does not disclose processing the multi-dimensional dataset in a multi-resolution framework. However, Lindeberg discloses multi-resolution sampling of a multidimensional dataset (page 25, section 7.1). One of ordinary skill in the art at the time the invention was made would have been motivated to modify the method taught by Li to include multiresolution process the multi-dimensional dataset in a multi-resolution framework as taught by Lindeberg in order to improve computational efficiency (Lindeberg, page 25, section 7.1, first paragraph).

Li further discloses isolating a selected region of interest from said multidimensional dataset and establishing a multidimensional datasubset, said selected region of interest comprising a subset of the imaging volume (col. 12, lines 12-34);

convolving said multidimensional datasubset, separate from the multi-dimensional dataset, with an analytic function to obtain a first convolution product (Fig. 11; col. 10, line 46 – col. 11, line 60); and

determining a plurality of derivative approximations to an analytic function (col. 10, line 6-37).

Li does not explicitly disclose determining a plurality of discrete derivative approximations to an analytic function. However, Lindeberg clearly teaches using the discrete approximations of an analytic function (discrete derivative approximations) to determine the

second order derivatives for use in a feature detector (Abstract; page 19, Section 6.1.3, second paragraph; page 16, Figure 3). It would have been obvious to one of ordinary skill in the art that the method taught by Li could be modified to include determining a plurality of discrete derivative approximations to an analytic function as taught by Lindeberg because the discrete approximations can be computed directly from smoothed image values at different scales without the need for repeating the smoothing operation, thus reducing the computation requirements making it more efficient (Lindeberg, page 2, lines 32-41 (last full paragraph); page 12, section 4.1).

Li and Lindeberg are silent with regard to optimizing said discrete derivative approximations in a least squares sense to reduce an error between said plurality of discrete derivative approximations and said analytical derivative of said analytic function. The Examiner takes Official Notice that optimization in a least squares sense if well known in the art and it would have been obvious to one of ordinary skill in the art to optimize the discrete derivative approximations in a least squares sense to reduce an error between the discrete derivative approximations and the analytical derivative of the analytic function because optimization using least squares techniques is exceedingly well known for quantifying and reducing differences (error) between two functions.

The combination of Li and Lindeberg further discloses convolving said first convolution product with the plurality of discrete approximations of partial derivatives of an analytic function to create a plurality of second convolution products (Li, Fig. 11; col. 10, line 46 – col. 11, line 60);

forming a plurality of Hessian matrices from said plurality of second convolution products (Li, Fig. 11; col. 11, line 44 – col. 12, line 11);

determining a plurality of eigenvalue decompositions for said plurality of said Hessian matrices (col. 9, line 63 – col. 10, line 5); and

combining eigenvalues resultant from said decompositions to represent spherical and cylindrical responses to elements of said multidimensional datasubset (Li, col. 6, line 10 – col. 9, line 62).

Regarding claim 17, Li further discloses a system for processing of a multi-dimensional dataset corresponding to an imaging volume (col. 4, lines 59-67; col. 18, lines 37-44), the system comprising:

a means for accessing the multi-dimensional dataset (col. 18, lines 37-44; col. 19, lines 29-40);

a means for isolating a selected region of interest from the multi-dimensional dataset, said selected region of interest comprising a subset of the imaging volume(col. 18, lines 37-44; col. 12, lines 12-34)

a means for generating a plurality of differential operators for selected region of interest, separate from the multi-dimensional dataset, using an approximation of an analytic function (col. 18, lines 37-44; col. 7, line 11 – col. 10, line 37; col. 12, lines 30-67); and

a means for forming a plurality of geometric responses based on a plurality of differential operators resultant from said generating (col. 18, lines 37-44; col. 6, line 10 – col. 7, line 32; col. 12, lines 30-67).

Li discloses generating a plurality of differential operators for the multi-dimensional dataset using approximations of an analytic function (col. 10, line 6-37) but does not explicitly disclose using a discrete approximation of an analytic function. However, Lindeberg clearly teaches using the discrete approximations of an analytic function (discrete derivative approximations) to determine the second order derivatives for use in a feature detector (Abstract; page 19, Section 6.1.3, second paragraph; page 16, Figure 3).

The teachings of Li and Lindeberg are combinable because they are both concerned with using filters derived from second order derivatives for feature extraction. It would have been obvious to one of ordinary skill in the art that the system taught by Li could be modified so the generating of a plurality of differential operators for the multi-dimensional dataset uses a discrete approximation of an analytic function as taught by Lindeberg because the discrete approximations can be computed directly from smoothed image values at different scales without the need for repeating the smoothing operation, thus reducing the computation requirements making it more efficient (Lindeberg, page 2, lines 32-41 (last full paragraph); page 12, section 4.1).

Regarding claim 18, Li discloses a system for processing of a multi-dimensional dataset corresponding to an imaging volume (col. 4, lines 59-67), the system comprising:

an imaging system comprising;

a radiation source configured to generate a radiation beam incident upon an object,

a radiation detector, said radiation detector configured to receive an attenuated radiation beam responsive to said radiation beam incident upon said object and produce an electrical signal responsive to an intensity of attenuated radiation beam, and

wherein said radiation source and said radiation detector disposed about an object cavity.

Li discloses the multi-dimensional dataset can be obtained from an X-ray CT apparatus (col. 19, lines 29-31; col. 12, lines 12-34). The above limitations are inherent to a conventional X-ray CT apparatus being used to image an object.

Li further discloses a processing device in operable communication with said radiation detector configured to execute a method for processing of a multi-dimensional dataset corresponding to an imaging volume (col. 18, lines 37-44; col. 19, lines 29-40), the method comprising;

accessing the multi-dimensional dataset (col. 19, lines 29-40),

isolating a selected region of interest from the multi-dimensional dataset, said selected region of interest comprising a subset of the imaging volume (col. 12, lines 12-34),

generating a plurality of differential operators for selected region of interest, separate from the multi-dimensional dataset, using an approximation of an analytic function (col. 7, line 11 – col. 10, line 37; col. 12 , lines 30-67), and

forming a plurality of geometric responses based on a plurality of differential operators resultant from said generating (col. 6, line 10 – col. 7, line 32; col. 12, lines 30-67).

Li discloses generating a plurality of differential operators for the multi-dimensional dataset using an approximation of an analytic function (col. 10, line 6-37) but does not explicitly disclose using a discrete approximation of an analytic function. However, Lindeberg clearly

teaches using the discrete approximations of an analytic function (discrete derivative approximations) to determine the second order derivatives for use in a feature detector (Abstract; page 19, Section 6.1.3, second paragraph; page 16, Figure 3).

The teachings of Li and Lindeberg are combinable because they are both concerned with using filters derived from second order derivatives for feature extraction. It would have been obvious to one of ordinary skill in the art that the method taught by Li could be modified so the generating of a plurality of differential operators for the multi-dimensional dataset uses a discrete approximation of an analytic function as taught by Lindeberg because the discrete approximations can be computed directly from smoothed image values at different scales without the need for repeating the smoothing operation, thus reducing the computation requirements making it more efficient (Lindeberg, page 2, lines 32-41 (last full paragraph); page 12, section 4.1).

Regarding claim 19, Li discloses a computer data storage device, said computer data storage device including computer readable program code, the computer readable program code comprising a method for processing of a multi-dimensional dataset corresponding to an imaging volume (col. 18, line 45 – col. 19, line 20). Regarding the method, arguments analogous to those presented above for claim 1 are applicable to claim 19.

Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Li and Lindeberg as applied to claim 1 above, and further in view of "Automatic

Lung Segmentation for Accurate Quantitation of Volumetric X-Ray CT Images" by Hu et al. (hereafter "Hu").

Regarding claim 9, Li further discloses said isolating a selected region of interest includes image threshold filtering configured to eliminate selected portions of the imaging volume (col. 12, lines 12-55) but is silent with regard to a morphology process. However, Hu teaches a lung segmentation method including morphological processes (page 493-494, Section C).

The teachings of Li and Hu are combinable because they are both concerned with segmenting lung regions from CT images. It would have been obvious to one of ordinary skill in the art at the time the invention was made for the isolating of the region of interest taught by Li to include morphological processing as taught by Hu so the automatic isolation/segmentation more closely mimics segmentation performed manually (page 493, Section C, second paragraph).

Regarding claim 10, Li further discloses said isolating a selected region of interest further includes isolating lung tissue for a pair of lungs comprising filtering with a threshold algorithm (col. 12, lines 12-55) but does not explicitly disclose the steps recited in claim 10.

Hu discloses:

filtering with a high threshold algorithm to isolate solid tissue and bone (page 491, Section A.1);

filling holes with a three-dimensional hole-filling algorithm to fill a portion of remain contained inside said solids (page 491, Section A.2);

filtering with a low threshold algorithm to isolate parenchyma of a pair of lungs from the solid tissue and bone (page 491, Section A.1);

splitting and isolating said pair of lungs with a morphology erosion algorithm (page 491-493, Section B;

closing and filing airways and vascular structures entering said pair of lungs with a morphology closure algorithm (page 493, Section C.1); and

filling remaining holes with a three-dimensional hole-filling algorithm to yield another multidimensional dataset corresponding to the selected region of interest (page 494, Sections 4 and 5; Fig. 3).

The teachings of Li and Hu are combinable because they are both concerned with segmenting lung regions from CT images. It would have been obvious to one of ordinary skill in the art at the time the invention was made for the isolating of the region of interest taught by Li to include steps recited claim 10 as taught by Hu so the automatic isolation/segmentation more closely mimics segmentation performed manually (page 493, Section C, second paragraph).

Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Li and Lindeberg as applied to claim 11 above, and further in view of "Automatic Lung Segmentation for Accurate Quantitation of Volumetric X-Ray CT Images" by Hu et al. (hereafter "Hu").

Regarding claim 13, Li further discloses said isolating a selected region of interest includes image threshold filtering configured to eliminate selected portions of the imaging

volume (col. 12, lines 12-34) but is silent with regard to a morphology process. However, Hu teaches a lung segmentation method including morphological processes (page 493-494, Section C).

The teachings of Li and Hu are combinable because they are both concerned with segmenting lung regions from CT images. It would have been obvious to one of ordinary skill in the art at the time the invention was made for the isolating of the region of interest taught by Li to include morphological processing as taught by Hu so the automatic isolation/segmentation more closely mimics segmentation performed manually (page 493, Section C, second paragraph).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anthony Mackowey whose telephone number is (571) 272-7425. The examiner can normally be reached on M-F 9:00-6:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Brian Werner can be reached on (571) 272-7401. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AM
2/13/08

BRIAN WERNER
SUPERVISORY PATENT EXAMINER